

## FINAL REPORT

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to  
Defense University Research Instrumentation Program (DURIP)

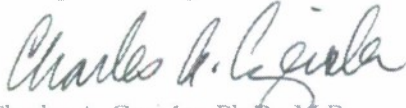
AFOSR/NL  
801 N. Randolph Street, Room 3112  
Arlington, VA 22203-1977

by  
Harvard Medical School  
25 Shattuck Street  
Boston, Massachusetts 02115

**Translating the Science of Alertness and Performance from Laboratory to Field:  
Using State-of-the-Art Monitoring, Imaging and performance Enhancement Technologies to Improve  
the Alertness and Safety of the Military and Civilian Workforce**

**Grant Number: FA9550-07-1-0242**  
Performance Period: April 1, 2007 –March 31, 2008

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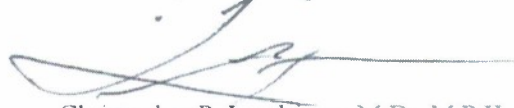


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13. SUPPLEMENTARY NOTES					
14. ABSTRACT The funds of this DURIP grant were used to acquire state-of-the-art equipment and technologies that will promote DOD-related research in the Division of Sleep Medicine of the Harvard Medical School. This site is part of an AFOSR-funded PRET Center that studies human alertness and performance and develops countermeasures to prevent attentional failures due to sleep deprivation and circadian misalignment (e.g., jet lag). The DURIP equipment requested would substantially enhance the research infrastructure in the university, and enable the conduct of advanced laboratory and field studies not currently possible. It will promote state-of-the-art education in the science and field application of alertness and fatigue countermeasures for the numerous trainees in the laboratory's active training program. A focus on translation from laboratory to field will aid in the understanding of real-world alertness and performance among military and civilian workers across occupations, and development of practical countermeasures. These technologies will ultimately enable enhancements in the performance and field readiness of military personnel.					
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a. REPORT  U	b. ABSTRACT  U	c. THIS PAGE  U			19b. TELEPHONE NUMBER (Include area code) 617-732-4013

## 2. Objectives:

The objectives of this grant were to acquire state-of-the-art equipment and technologies that would substantially enhance the research infrastructure in the university, and enable us to conduct advanced laboratory and field studies not currently possible. Also, to promote state-of-the-art education in the science and field application of the assessment of human alertness and fatigue countermeasures for the numerous trainees in the laboratory's active training program.

neurobehavioral performance both in laboratory settings as well as in field studies. The equipment/technologies included a) eye tracking with dynamic pupil size measurements used in both laboratory and digital electroencephalogram (EEG) and electrooculogram (EOG) recording systems for ambulatory use as well as for use in functional magnet-resonance imaging (fMRI) environments, b) custom 32 channel electrode caps for use in fMRI environments, new EEG/EOG signal analysis software, c) ambulatory Optalert systems for detection of states of hypovigilance, d) new (next generation) actigraphy monitoring devices, and e) specialized green fluorescent lamps (~500 nanometer wave length) some with free standing fixtures, mono-chromatic light presentation system (Light Cannon) and g) a reliable state-of-the-art database/mass data storage system that permits effective archiving and management of the data acquired with the new systems.

## 3. Status of Effort:

We have received and implemented the technologies systems listed under "2. Objectives." In the case of the Eye tracking system EEG/EOG recording devices and signal analysis software we have over the grant period worked closely with the manufacturer to improve and customize the systems beyond what was commercially available at the beginning of the grant period. The newly implemented equipment is already IRB approved for in use in several research projects (see "4. Accomplishments/New Findings"). The ambulatory equipment (Optalert and actigraphy monitoring device) are in the process of being deployed in field studies supported by NASA, CDC, NIH as well as in laboratory studies supported by AFOSR, NSBRI and NIH.

## 4. Accomplishments/New Findings:

The equipment acquired under this the DURIP grant provided the state-of-the-art infrastructure which is allowing that allowed us to gather more detailed data required for our obtain a competitive research grant from AFOSR grant entitled "Interaction of chronic sleep restriction and circadian misalignment on sleep and neuro-cognitive performance: developing a new model of sleep homeostasis."

Furthermore, this equipment is supporting The studies funded by this research grant have just started and are using as an essential element the new equipment/technologies purchased under the DURIP grant. Furthermore, the new EEG signal analysis software is being used in the analysis of data collected from 18 subjects in the previous AFOSR PRET investigation

"Homeostatic and Circadian Regulation of Wakefulness During Jet Lag and Sleep Deprivation: Effect Wake-Promoting Countermeasures." We also have received grants from the National Institute of Justice entitled "Testing the Effectiveness of a Comprehensive Police Fatigue Management Program" and the Centers for Disease Control entitled "Sleep Disorders Management, Health and Safety in Police" that both employ actigraphy in a large-scale field study. We have equipped 20 police officers on duty with wrist-actigraphy monitors that were purchased with the DURIP grant, and 140 more officers have been recruited to start wearing actigraphy monitors in the next few weeks.

As a direct result of this award, we have received a grant from NSBRI entitled "Effects of Acute Sleep Deprivation on Visual Attention and Gaze Control" and an NIH grant entitled "Bright Light Treatment of shift rotation in Insomnia" which uses the eye tracking / pupil metrics system. The new lighting technologies are being used in two NSBRI grants entitled "Evaluation of Blue-enriched Light as a Countermeasure for Circadian Entrainment, Enhancement of Neurobehavioral Performance and Sleep-Wake Regulation Before and During Space Flight" and "Designing Individual Countermeasures to Reduce Sleep Disruption and Improve Performance and Alertness in Space." There was also on NASA grant entitled "Phoenix Scout Lander: Countermeasures Testbed for Spaceflight Ground Controllers"

5. Personnel Report:

There are no budgetary costs for personnel.

6. Publications:

None. Studies with new equipment are ongoing

7. Interactions/Transitions:

A. Participation/presentations:

None

B. Consultative and advisory functions:

None

C. Transitions:

The data collected and analyzed with the purchased equipment/technologies will be used to refine our develop a new dynamic model of sleep homeostasis that accounts for the influences of sleep restriction and individual differences on multiple aspects of neurocognitive performance and light exposure. This model is being developed as part of the currently funded AFOSR project (see above). The model will facilitate optimization of human performance in operational settings that involve chronic sleep restriction that are seen in Air Force operation and other work environments.

8. New discoveries, inventions, or patent disclosures:

None

9. Honors/Awards:

- 2007 Inducted to Honorary Fellowship (20 in world) of the Royal College of Physicians, London (F.R.C.P.)
- 2008 Elected as Member, American Clinical and Climatological Association
- 2008 Lifetime Achievement Award, 2005 Recipient of the NIOSH Director's Award for Scientific Leadership in Occupational Safety and Health
- 2006 Recipient of the National Sleep Foundation, 2006 Healthy Sleep Research Society Community Award (Harvard Work Hours and Health and Safety Group)
- 2008 Lord Adrian Medal, Royal Society of Medicine, London
- 2008 Distinguished Scientist Award, Sleep Research Society